

## Description

Method for determining the position of defective shielding of a coaxial cable or connector in a coaxial cable network.

Television distribution networks, also known to experts as CATV networks are predominantly realized by coaxial cables or coaxial cable networks in which, in order to avoid the radiation of the transmitted television signals, one or two metallic shields - usually aluminum foil, but also copper foil or braiding - surrounds or surround the information conductors - i.e. inner conductors. The shielding is preferably connected to the local ground potential layer.

During the installation of such coaxial cable networks, in particular television distribution networks, technically inappropriate laying and technically inappropriate handling mean that the shielding of the coaxial cables incurs damage or high contact resistances arise due to faulty assembly of the connectors. The damage to the shielding is either a destroyed shielding or is constituted by slits in the shielding which are produced during the laying of the coaxial cables as a result of excessively small bending radii, excessively high mechanical stress or as a result of major movements or deformations caused after installation - in particular in the case of laying in the open.

Prior to use of the coaxial cable networks or in the event of complaints concerning excessively low quality of the communicated television signals or radiation of signals in the return channel frequency range, the coaxial cable networks are checked for defective shielding - also called leakage points by experts - as a result of which the television signals to be transmitted are radiated into the open and external signals penetrate into the coaxial cable and

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interfere with the television signals or return channel signals.

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In order to find such leakage points or the position of defective shielding of a coaxial cable, a signal having a frequency of approximately 130 MHz, modulated with a sound signal, is coupled into the coaxial cable. <sup>In</sup> ~~in~~ this case, the frequency chosen lies in the lower region of the frequency range provided for the television distribution. A receiver tuned to the coupled-in signal is in each case guided along the coaxial cable to be examined and is observed in respect of reception of the coupled-in signal. In this case, in particular the measured field strength of a received, coupled-in signal is used to judge the position of the defective shielding of the respective coaxial cable. In principle, the higher the measured field strength, the closer the position of the defective shielding. A further criterion for determining the position of the defective shielding is the sound signal, which is acoustically reproduced after demodulation of a received signal. With this measurement method, the position of defective shielding can be delimited only to a region of approximately 20 m, since the sheath wave produced by the defective shielding propagates 10 to 20 m on the shielding in both directions - given the use of a coupled-in test signal of approximately 130 MHz - as depends on the surroundings of the coaxial cable, e.g. masonry, concrete or steel support - and said sheath wave is received with a different field strength in this region by the receiver and the sound signal is acoustically reproduced.

30 The object <sup>on</sup> ~~on~~ which the invention is based is to determine the <sup>position</sup> ~~position~~ of the defective shielding of a coaxial cable more precisely. The object is achieved by means of the features of patent claim 1.

<sup>present</sup> The essential aspect of the method according to the invention is to be seen in the fact that a first signal modulated by a first sound signal and having a first frequency and a second signal modulated by a second sound signal and having a

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second frequency are coupled into the coaxial cable, where the second frequency is higher than the first frequency and the sound signals have a different sound frequency. A receiver designed for the reception of the two signals is guided along the coaxial cable, and when the first signal is received, the first sound signal is acoustically reproduced, thereby indicating defective shielding in a region, and when the second signal is received, the second sound signal is acoustically reproduced, thereby establishing the position of the defective shielding. When both signals are received simultaneously, both sound signals are audible when the position of the defective shielding of the coaxial cable is found. ~~In an advantageous manner, the first frequency of the first signal is chosen to be in the range of 100 to 200 MHz and the second frequency of the second signal is chosen to be in the upper transmission range of the coaxial cable -~~ <sup>In an embodiment, the</sup> ~~claim 2.~~ The second frequency of the second signal is advantageously chosen in such a way that the determination of the defective shielding of the coaxial cable can be carried out when the coaxial cable has been installed and operated, ~~claim 3~~ e.g. including between sound carrier and upper adjacent vision carrier. By coupling in a second signal which is modulated by a second sound signal and whose frequency lies in the range of the operating frequencies, that is to say in the range of the frequency of the television signals, once the 10 to 20 m region has been found, the position of the defective shielding of the coaxial cable to be checked can be localized significantly more precisely, since, in the event of defective shielding, because of the significantly higher frequency and hence higher sheath wave attenuation, the second signal propagates on the coaxial cable in a very small region, that is to say a region measured in centimeters, and is otherwise radiated into the free space.

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*In an embodiment*

~~1~~ A According to a particularly advantageous development of the method according to the invention, the frequencies of the first and second signals are chosen in such a way that an amateur radio receiver  
5 designed for the simultaneous reception of two signals can be used as the receiver for the reception

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A of the two signals ~~claim 5~~. This choice of the first and second frequencies means that it is possible to use commercially available receivers which are particularly inexpensive and manipulable. Because of their  
5 manipulability, these amateur radio receivers can easily be guided along the coaxial cables to be checked and, at the same time, the field strength can be observed and the acoustically reproduced first and second sound signals can be monitored. Furthermore,  
10 this amateur radio receiver can advantageously be used additionally as a local communications device, for example as a construction site telephone, in the cable networks, which are usually spread out geographically.

A *In an embodiment, the transmission level of*  
A ~~According to a development of a method~~

A 15 ~~according to the invention, the transmission level of~~  
the first and second signals is matched to the reception properties of the receiver and/or the received signals (s1, s2) are attenuated in the receiver ~~claim 6~~. For attenuating the received  
20 signals in the receiver, it is possible to insert attenuation plugs, e.g. 80 ohms, 20 dB, into the antenna.

A *In an embodiment, the*  
A According to a further advantageous refinement of the method according to the invention, the  
25 Sub Audio Squelch method is optionally integrated.

A ~~According to this method~~  
A ~~claim 7. In these methods, a lower audiofrequency range,~~  
e.g. 0-300 Hz, is suppressed and a tone or pilot  
A tone having a frequency of 85.4. Hz provided in the  
30 case of amateur radio equipment, for example, is transmitted. If this transmitted tone is received with a sufficient level in the receiver, the acoustic reproduction device, that is to say amplifier and  
A loudspeaker, is enabled, or inhibited in the event of an insufficient level - referred to as squelch function by  
35 experts.

A *Sub*  
The method according to the invention is explained in more detail below with reference to two drawings, in which:

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Figure 1 shows an arrangement for carrying out the method according to the invention in a coaxial cable network,

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Figure 2A shows, in a block diagram, the essential components of a receiver according to the invention and

Figure 2B shows the operator interface of a receiver according to the invention.

Figure 1 shows part of a coaxial cable network KN, which usually has a tree structure and is represented by a coaxial cable K. The coaxial cable K is represented by two lines drawn parallel and a dashed line indicating the inner conductor. During operation, television signals fs are transmitted via the coaxial cable K or via the coaxial cable network KN to transfer points - television connection boxes (not illustrated)

- and from there are forwarded to TV devices, not illustrated. For coupling in the signals ~~s1, s2~~ <sup>(not s1, s2)</sup>

according to the <sup>present</sup> invention, a coupler KP or the collector array of a TV head end is inserted into the coaxial cable K. A transmitter ~~S~~<sup>T</sup> is connected to said coupler KP via a coaxial line KL. Two signal generators G1 and G2 are contained in said transmitter ~~S~~<sup>T</sup>.

For the exemplary embodiment, it shall be assumed that a first signal ~~S1~~<sup>s1</sup> having a first frequency f1 = 130 MHz is formed in the first signal generator G1. This first signal ~~S1~~<sup>s1</sup> is frequency-modulated with a first sound signal ts1 and with a first sound frequency tf1 = 400 Hz, with a 2 kHz swing. Analogously to this,

a second signal S2 having a second frequency f2 = 750 to 990 MHz or 400 to 500 MHz is formed in the second signal generator G2. The second signal ~~S2~~<sup>s2</sup> is frequency-modulated with a second sound signal ts2 with a second sound frequency tf2 = 1 kHz, with a 2 kHz swing. Both the first signal s1 and the second signal s2 are coupled into the coaxial line KL via the coupler KP. For the exemplary embodiment, it shall be assumed

that the two signals s1, s2 are transmitted into the coaxial cable K in the direction indicated by the dotted line provided with an arrow. For the exemplary embodiment, it shall furthermore be assumed that the

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shielding S is defective at the position P identified by P - indicated by the designation S(d) in Figure 1. On account of this defective shielding S(d),

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part of the transmitted energy of the signals  $s_1$ ,  $s_2$  escapes from the coaxial cable K and propagates on the outer conductor along the coaxial cable<sup>K</sup>. This propagation is referred to as the sheath wave mw by experts. The sheath wave mw of the first signal  $s_1$  having the lower frequency  $f_1$  propagates, given a sufficient level, approximately 10 to 20 m in both directions of the defective shielding S(d). The sheath wave ~~—~~ (not illustrated)<sub>^</sub> - of the second signal ~~s1~~<sup>s2</sup> propagates only a couple of centimeters on account of the considerably higher frequency  $f_2$ . This very small region is established as position P, since damage or a defect of the coaxial cable K or of the shielding S can easily be found once the said small region has been determined.

Figure 2A shows the fundamental structure of the receiver E in a block diagram. An antenna A is connected to two reception units EE1, EE2, the first reception unit EE1 being tuned to the reception of the first signal  $s_1$  and the second reception unit EE2 being tuned to the reception of the second signal  $s_2$ . If a first signal  $s_1$  with a sufficient level is received in the first reception unit EE1, then, after frequency demodulation and sound demodulation, a first sound signal  $ts_1$  is passed to an acoustic reproduction device AWE <sup>which is</sup> formed by an amplifier and a connected loud speaker<sub>^</sub>, where it is reproduced acoustically. Analogously to this, in the second reception unit EE2, when a second signal  $s_2$  is received, said signal is subjected to frequency demodulation and sound demodulation and a second sound signal  $ts_2$  is likewise passed to the acoustic reproduction device AWE, where it is reproduced. The receiver E furthermore contains a control unit ST, which monitors all the components of the receiver E and with the aid of which the frequency setting of the two reception units EE1, EE2 is performed. An input unit EE<sub>^</sub> <sup>which is</sup> usually realized by a keypad<sub>^</sub>, is provided for the inputting of the

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corresponding reception frequencies  $f_2$ ,  $f_2$ . A display  
unit AZE, <sup>which is</sup> usually realized by a liquid crystal display,

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is arranged for displaying reception-specific values. A power supply SV, which is realized for example by rechargeable accumulators, is integrated for supplying energy to all the components of the receiver E.

5 Figure 2B illustrates the operating interface of the receiver E. This is essentially formed by the display unit AZE, the input unit EE and the acoustic reproduction unit AWE. The reception frequencies  $f_1$ ,  $f_2$  of the two reception units EE1, EE2 are displayed in  
10 the display unit AZE, the two reception frequencies  $f_1$ ,  $f_2$  being set by the input unit EE, i.e. with the aid of a keyboard, in such a way that they correspond to the frequencies  $f_1$ ,  $f_2$  of the first and second signals  $s_1$ ,  $s_2$ . Furthermore, the reception level EP of  
15 the first and second signals  $s_1$ ,  $s_2$  is displayed in the display unit AZE. The magnitude of the reception level EP is in this case represented by bars whose length or height vary in accordance with the measured reception level EP.

A 20 According to the <sup>present</sup> invention the receiver E is guided along the coaxial cable K. If said receiver is brought into the region B, in which the sheath wave mw occurs, then firstly the first signal  $s_1$  is received in the receiver E and, given a sufficient reception level  
A 25 EP the first sound signal  $ts_1$  is acoustically reproduced. If the receiver reaches the position P or the very narrow region of the defective shielding S(d), then the second signal  $s_2$  is additionally received in the receiver E and, given a sufficient reception level  
30 EP, the second sound signal  $ts_2$  is passed to the acoustic reproduction device AWE, where it is likewise reproduced acoustically. This means that when the second sound signal  $ts_2$  is reproduced acoustically, the position P of the defective or damaged shielding S(d)  
35 is established, the position P lying in the region of a few centimeters of the coaxial cable K. The essential advantage of the method according to the <sup>present</sup> invention can  
A be seen in the fact that firstly the  
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region B encompassing a number of meters is determined and then, by the receiver E being guided precisely along the coaxial cable K, the position P of the defective shielding S(d) can be determined precisely.

- 5 In order to avoid the acoustic reproduction of noise given the lack of reception of the two signals s1, s2, the method which is referred to as "Sub Audio Squelch" by experts can be integrated both in the transmitter S and the receiver E. Amateur radio
- 10 receivers E usually have this performance feature. In this case, the lower sound frequency range, for example between zero and 300 Hz, is used in order to transmit a sound signal having a frequency of 85.4Hz. In the receiver, this sound signal is used to activate
- 15 or inactivate the acoustic reproduction device AWE. If this specific sound signal is received with a sufficient level, the acoustic reproduction unit AWE is activated, otherwise it remains deactivated.

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